



# Proceedings

The 2<sup>nd</sup> International Language and Language Teaching Conference

Friday-Saturday, 25-26 September 2015  
at Sanata Dharma University, Yogyakarta, Indonesia

**English Language Education  
Sanata Dharma University**

Jl. Affandi, Mrican, Caturtunggal  
Depok, Sleman  
Yogyakarta 55281  
(+62)274-513301



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Published by

English Language Education Study Program

Sanata Dharma University

Jl. Affandi, Mrican Catur Tunggal Depok Sleman Yogyakarta 55281

Telp: (0274) 513301, 515352 ext. 1131

ISBN 978-602-18681-9-5

# Preface

The Organizing Committee are delighted to present the proceedings of the Second International Language and Language Teaching Conference (2nd LLTC), whose main theme is English as a Second Language (ESL) Teaching in the 21st Century: Research and Trends. There are 87 full papers in the compilation, covering various topics in language learning-teaching, linguistics and literature, mostly related to the English language. As an academic forum, LLTC is organized by the English Language Education Study Programme of Sanata Dharma University or *Program Studi Pendidikan Bahasa Inggris (Prodi PBI) Universitas Sanata Dharma (USD)* Yogyakarta. It is expected that all complete papers in the proceedings will enrich our knowledge and broaden our insights into language learning-teaching, linguistics and literature.

Editors



# Table of Contents

Preface .....	i
Learners' Intercultural Competence as Communicative Competence in Teaching English for Young Learners ..... Agnes Widyaningrum	1
Developing Reading Strategy Training guidebook for Senior High School Level ..... Alfan Zuhairi and Nurul Afidah	11
Teaching and Learning Method in Inclusive Classroom: A Case Study in EAP Class at Sampoerna University ..... Anddy Steven, Athifah Utami, Rangga Akbar Sahidin, and Victor HutomoDesetyadi	17
Language Problems with Special Reference to Bodo Language in North-East India ..... Araiswring Basumatary	29
Culture Immersion in Molding the Novice EFL Teachers' Identity ..... ArcciTusita, Nurul Laili Nadhifah, and Ive Emaliana	35
Assisted Final Project of Developing Tutorial Video: Strategy to Improve the Non-English Department Students' Language Skills through Meaningful Activities ..... Arum Puspitasari	43
A Study of Experiential Learning in the Teaching of Drama ..... Ayu Liskinasih	49
Designing English Material for Psychology: A Case Study ..... Azhar Aziz Lubis, Fitria Muji Pratawati, and Ardhan Suseno	55
Headwords and Hyponymy Consistencies of Vegetable Definitions ..... Barli Bram and Hernita Ratna Aulia	59
Developing Language Assessment Literacy: Its Importance and Implication ..... Dang Arif Hartono	71
Meaning Negotiation in Conversational Interactions: A Method to Create Language Environment in the Classroom ..... Denok Sari Saputri and Yulia Isnani	75
A Study of Students' Attribution for Success and Failure in Speaking English ..... Dian Puisi	91
The Implementation of Concept-Oriented Reading Instruction (CORI) in Order to Improve Students' Reading Comprehension ..... DitaSurwanti	97
Correlating Communicative Language Teaching with Character Education in English Teaching .. Dodi Siraj Muamar Zain	105
English Contents or Contents in English to Help ESP Students Improve English Communicative Ability ..... Dominique Savio Nsengiyumva	113
A Comparative Account of Communicative Dynamism among Three Versions of <i>The Lord</i>	123

<i>Prayer: English, Indonesian, and Javanese</i> .....	
Emanuel Sunarto	
Politeness Strategies of <i>CekGu Jasmine</i> on “ <i>UpindanIpin (English Version)</i> ” Cartoon Movie in Episode “ <i>When I Grow Up</i> ” .....	133
Eka Anggia Rini	
Integrating Internet-based Technology in a Foreign Language Teaching: Fostering Students’ Outcome .....	141
EkaWahjuningsih	
Pedagogical Content Knowledge in Teaching English Writing and Its Challenges in the Indonesian Context .....	149
Faisal	
English Code-Mixing in Four Age-Based Indonesian Magazines .....	163
Nabila Muliawati	
Assessment in EAP English Literature Courses .....	171
Neil Conway	
Code Switching of Cross Caste’s Marriage in Balinese Family .....	177
Ni Putu Isha Aprinica	
Acquiring A Second Language: Siblings’ Influence and Parental Help .....	183
Novi Rahayu Restuningrum	
A Semantic Study of English:Verb–Noun Functional Shift .....	193
Nurvita Wijayanti and Gatri Asti PutriIndarti	
Undergraduate Students’ Problems in Writing a Research Paper: An Analysis of the Causes .....	201
Nuur InsanTangkalangi and Widyasari	
Relevance to the Detriment of Accuracy: The Future of the Writing Skill .....	207
Oscar Ndayizeye	
Teachers’ Beliefs about the Curriculum 2013 Implementation in their Classrooms .....	215
Veronica Triprihatmini and Agustinus Hardi Prasetyo	
The Use of Ice Breakers in English Learning and Teaching .....	227
Ramea Agus Purnama	
Cultural Analysis on Attitudes toward MALL in Higher Education: a Case Study .....	233
Risa Rumentha Simanjuntak	
Traditional Media Still Exist in Digital Era: Maximizing Pictures In TEFL .....	241
Rizky Amelia	
Exploring Language Learning Strategy Use and Its Relation to Academic Self-Concept: The Case of Indonesian EFL Students .....	249
Rosyi Amrina	
The Beliefs and Practices of ESL Teachers about Teaching High-Order Thinking Skills .....	259
Sanmuganathan Nagayar, Azianbt.Abd, and Mangala Nayahi Kanniah	
The Impacts of Immersion For Learning English: A Comparative Study of Private Junior-High School Students in Surabaya, Indonesia .....	271

Singgih Widodo Limantoro

Improving Students' Speaking Achievement in Expressing Offering by Using Role Play Technique .....	279
Siti Nurhayati, Sri Utari, Syarah Aisha, Saidatul Hanim, Enda C. Nora Ginting, and Arief Muadz	
Using Lectora Inspire to Develop and Arrange Students' Comprehend in Reading Narrative Text	285
Sofa Sofiatun Nufus	
Improving Students Writing Ability Through Jigsaw: A Classroom Action Research at The English Education Department, Ahmad Dahlan University Yogyakarta .....	291
Soviyah	
Using of Explicit Instruction Method in Improving Students' Grammar Ability in Simple Present Tense at Class X <sup>3</sup> of SMA Negeri 4 Leihitu .....	297
Stella R. Que and Ayu Aprilya S. Abdullah	
Evaluative Analysis of the Implementation of Mobile-Web Application System to Improve Academic English Writing Skills .....	303
Sugeng Purwanto	
Exploring Communication Strategies Used by English and Non-English Major Students.....	311
Tanvir Hossain and Zhang Suting	
Nonverbal Communications Done By The Native Speakers in the Interview of Cross Cultural Understanding (CCU) Project at the Sixth Semester Students of English Education Program of Muhammadiyah University of Purworejo in the Academic Year 2014/2015 .....	319
Titi Rokhayati	
Cognitive Linguistic Analysis of Polysemy Lexeme CUT .....	329
Truly Almendo Pasaribu	
Inquiry Based English Learning to Foster Metacognitive Skill .....	339
Tusino	
English Teachers' Strategies in Assessing The Students' Learning Performance Based on 2013 Curriculum .....	345
Ummu Syahidah	
Using Arts in English Classes to Promote Writing to First Year College Students .....	355
Sri Rejeki Murtiningsih	
Scaffolding: Teacher-students Interaction in the Initial Lesson of ESL Classroom .....	363
Valentina Siwi Nugroho Widhi	
Senior Support Programmeamong Lower Levels of English Proficiency Students in an English Improvement Programme .....	369
Vikineswaran A. Maniam, Phang Siew Sia, Marshall Kennedy, and Natalie Canham	
Students' Perceptions of the Importance of Integrating the Target Culture using ELT Authentic Materials .....	379
Widyasari, Nur Insan Takelang, and Diah Safithri Armin	
Using Facebook with Process Writing Strategy to Enhance the Teaching of Recount Text .....	391
Wihda Nadia Silcha and Francisca Maria Ivone	
	399

Using Edmodo as Modern Technology to enhance the Students' English Language Skills .....	
Yusawinur Barella	
The Effects of Literature Discussion in EFL Book Report Class .....	407
Yuseva Ariyani Iswandari	
Empowering New Writers with Revising Technique .....	415
Mega Wati	
Needs Analysis to Develop an ESP Syllabus for Biology Students: A Task-Based Approach .....	421
Meti Rahmawati and Rosyida Asmaul Husna	
Teaching Character and Point of View to Enhance Students' Understanding: A Study in Prose Class .....	429
Mia Fitria Agustina	
Using E-Learning of Jenderal Soedirman University (El-Diru®) to Teach Grammar: Students' Perspective .....	437
Mia Fitria Agustina, Ririn KurniaTrisnawati, and Agus Sapto Nugroho	
Teaching Critical Writing by Using Peer-Editing Technique .....	449
Miftahul Janah	
English Language Education Study Program Students' Self-Perceived Listening Comprehension Strategies: Identifying the Problems .....	457
Christina Lhaksmita Anandari	
Communicative Competence (Cc) and Communicative Language Teaching (CLT) .....	465
Muh Kuntoaji	
Affective Factors Influencing the Involvement of EFL Instructors in e-Learning in Saudi Universities .....	475
Mohammed A. Zaid	
The Application of Jigsaw Technique in Improving the Students' Achievement in Speaking .....	491
Muhammad Yusuf, Ridwan Hanafiah, Aprilza Aswani, Nazliza Ramadhani	
Top Down Strategy to Provide Background Knowledge of Contextual Material in Vocational High School .....	499
Fitriya Dessi Wulandari	
Learners' Use of Learning Strategies in a Web-Based Listening Environment .....	505
Francisca Maria Ivone	
Collocation: Theoretical Considerations, Methods and Techniques for Teaching It .....	515
H. Saudin	
Promoting Speaking-Strategies Based Training for Junior High School Students' Autonomy .....	523
Alfan Zuhairi, Hanifah	



The Influence of Introducing Semantic Knowledge to Improve Students' Paraphrasing Skills .....	529
Intan Pradita	
Strategies-Based Instruction of Writing Skill to Senior High School EFL Learners in Indonesia .....	537
Junaidi Mistar and Nurul Abidah	
An Analysis of Speech Acts Produced by Teacher in Conducting Teaching Learning of English .....	545
Juni Hartiwi	
The Benefit of Indirect Comprehensive Error Corrections in Improving Advanced EFL Learners' Writing Accuracy .....	551
Katharina Rustipa	
Introducing Drama to an EFL Classroom: Student's Perceptions in Short Story .....	559
Lasma Dwina	
Native-Speakers as English Language Instructors in Higher Learning Institutions .....	567
Faizah Mohamad Nor	
Communicative Strategies for Communication among Students in Various English Proficiency Levels .....	575
Lucyana Dorothy Siahaan, Agnes Siwi Purwaning Tyas, and Rieta Anggraheni	
Trace the Moral Doctrine Implied in "Serat Wulang Sunu" Script; Philology Approach .....	583
Aang Fatihul Islam	
The Difference of Grammar Translation Method and Contrastive Analysis on Aspect and Tense System between Indonesian and English toward Students Grammar Achievement .....	595
Andi Dian Rahmawan	
Semantic Analysis: Swear Words in Bahasa Batak Toba .....	597
Devi Melisa Saragi	
World Cultures Exhibition: Empowering Students' Global Identity through English .....	605
Inggrit O. Tanasale and Bella C. F. Camerling	
Legitimizing Multiple Identities through Focused Reading Group (FRG) "Language, Culture and Identity" .....	611
Inggrit O. Tanasale	
Indonesian ELT Practitioners Writing in Australia: Previous Writing Experience and Negotiation to Dominant Writing Practices .....	617
Nova Ariani	
Acoustic Analysis of English Vowel Formant Frequencies Produced by Indonesian Native Speakers .....	625
Rudha Widagsa	
The 'Two Sides' of Learner Autonomy in English Language Learning .....	635
Sukasih Ratna Widayanti	

Assessing English Teaching Knowledge through Online Case – Based Analysis .....	639
Sunu Dwi Antoro	
How New Technology Trend Has Changed Learning Culture .....	647
Tri Wahyuni Floriasti	
The Translation of ‘ <i>κην</i> ’ into English Modal Auxiliaries: An implication for English Grammar Textbook Revision .....	655
Peerapat Yangklang	
Second Language Literacy and Its Impact on the Writer’s Identity .....	671
Yofita Lawe Duka	
East Indonesian Perception on Long-Short Vowel Phonemes: A Sound Production Analysis .....	679
Yune Andryani Pinem	
Ecological Awareness in Students’ Creative Writings .....	693
Henny Herawati	
Theorizing Students’ Attributions on Their EFL Learning Process .....	703
Yustinus Calvin Gai Mali	
Student-Teachers’ Strategies in Giving Feedback in Teaching Speaking .....	715
Christina Kristiyani and Caecilia Tuttyandari	

## Acoustic Analysis of English Vowel Formant Frequencies Produced by Indonesian Native Speakers

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### Abstract

Each vowel has a unique structure of formant frequency which indicates the quality of the vowel. Formants have long been known as suited parameters for describing vowel production due to its correlation with traditional articulatory transcription of vowel. This study is intended to describe the characteristic of English vowels production of Indonesian native speakers (L2) based on formant frequencies. The frequencies of first formants (F1) and second formants (F2) of the vowels are analysed to describe the characteristics of English-L2 vowels production and perception. This study involves 10 students in English Department (PBI-UPY) who are native speakers of Indonesian as respondents. The data are analysed through several steps, firstly, data are collected through listening and recording 11 /hVd/ words representing 11 types of English vowels, secondly, the recordings are processed using PRAAT software to figure out the frequencies of F1 and F2 of each vowel (values in Hertz). Finally, both formants are plotted in Bark Scale to ease the process of describing the characteristic of English-L2 vowels production, simultaneously, the English-L2 F1 and F2 vowels are compared with similar vowels of English native speakers to figure out the differences so that the perception can be concluded. The result shows that the English vowels production of English-L2 tend to be very close to the nearest Indonesian vowels. It is proved by some distinct characteristics of English-L2 vowel productions compared with English-L1. The major differences appear in the production of vowel /i/ in 'heed' and /ɪ/ in 'hid' where the F1 and F2 frequencies of both vowels are identical (F1 403.5 Hz, F2 2070.4 Hz for /i/ and F1 416.5, F2 2065.5 for /ɪ/), English-L2 Learners are not able to discern the differences, both are pronounced as 'hid'. Another major distinctive utterance is /ɒ/ in 'hod' where F1 597.3 Hz and F2 1348.7 Hz, this vowel is closely perceived as /ɔ/ as in Indonesian 'tokoh' and the frequencies are in common with the vowel /ɔ/ as in 'hoard' produced English-L1. Furthermore, based on distant differences between F1 and F2, vowel /ɒ/ of English-L2 sounds more "front" instead of "back".

Keywords: *formant, frequencies, vowel, English-L1, L2*

### Introduction

Teaching English pronunciation in Indonesia could emerge some complicated problems since Indonesia has its own superior national language (*bahasa Indonesia* or Indonesian) and thousands of local languages which are mother tongues to its people. Mother tongues could interfere target language. As stated by Brown (2007:78) the process of second language (L2) acquisition is more sensitive to the interference of first language (L1). Pronunciation would be a major learning problem, though, because the sound systems of those two languages are quite different (Steinberg, 2001:233). It means that the background of the learners affect the learning of L2 or more accurately in the relationship with the character of contrast with L1 which lays in its system or rules.

Each language has its own rules including how the sounds of language are produced such as vowels and consonants. Human sound systems are very diverse. Consequently, this could trigger intelligibility problem when people from a particular language make an attempt to interact with people from a different language. Contrastive analysis hypothesis proposed by Lado (1957) was also based on the assumption that people who come into contact with a foreign language will find some features of it quite easy and others extremely difficult. Those elements that are similar to their native language will be simple for him, and those elements that are different will be difficult (1957:2).

Mother tongue interfere cannot simply be shaken off when speaker of the language gets older. Adults tend to stabilize their language learning at a certain stage. Nemser in Ellis (1994:309) claimed that learner speech was 'structurally organized' in the sense that it constituted a system in its own right. This process called fossilization; when a sound in L2 consistently replaced with a sound which is phonetically close to L1. Therefore, the speech production in L2 is different from the similar speech produced by a native speaker. Selinker (1972) also noted that relatively few adult learners reach native-speaker competence.

In learning a second language, the level of difficulty experienced by the learner will be directly related to the degree of linguistic difference between L1 and L2. Difficulty will manifest itself in errors; the greater the difficulty, the more frequent the errors (Ellis, 1994:308). Similarly, The difference between English and Indonesian vowel system could be a barrier for Indonesian learners of English who want to speak like native speakers.

The problems encountered by non-native speakers pronouncing or perceiving unfamiliar phonemes in L2 are well-known. Indonesian learners of English frequently have difficulties with English vowel system because there are dissimilarities in articulating vowel sounds of these two sound systems. This research aims at describing English vowel production pronounced by Indonesian native speakers (English-L2). This research uses formant frequencies to find out the characteristic of English vowels produced by English-L2.

In Indonesia, English pronunciation instruction mainly focuses on audio-lingual approach such as minimal pairs drills and articulatory descriptions. Correction and analysis of students' production generally depends on the teachers' subjective auditory judgement. In fact, one of the accurate ways to discern the differences would be based on acoustic analysis. Thus, this research attempts to investigate English-L2 production in English pronunciation by examining the acoustic difference between British English vowels and English vowels produced by English-L2.

### **English Vowels and the Acoustic Features**

Vowels are syllabic sounds made with free passage of air down the mid-line of the vocal tract, usually with a convex tongue shape, and without friction. They are normally voiced; and they are normally oral (Odgen, 2009:56). Vowels of English vary enormously by variety, many phoneticians have different perspective in defining the number of English vowels. Jones (1957:63) mentioned that there are eight vowels in Southern English, whereas Finegan (1992:40) proposed twelve vowels for Australian English. However, English has at least 11 pure vowel sounds or monophthongs.

All voiced sounds including voiced sounds made by human (vowel) have a fundamental frequency and harmonics, some of which are emphasized, depending on the resonant qualities of the vocal tract. These emphasized harmonics are the formants (Ball and Lowry, 2001:67). Speech analysts are usually concerned mainly with the first and the



second formant (F1 and F2). Each vowel has a formant structure which indicates vowel height, tongue advancement and lip shape. The first formant frequency (F1) is inversely related to vowel height. F1 corresponds to tongue height: close vowels have lower F1 values, and open vowels have higher F1 values while F2 usually reflects the front–back position of the tongue, with front vowels having higher F2 values than back vowels. Lip-rounding is indicated by a lowering of all of the formant values formants (Ball and Lowry, 2001:67, Ladefoged, 2011:196).

Formants have long been held to be acceptable parameters for describing vowel quality, mainly because F1/F2 plane correlates with traditional articulatory-auditory description of vowels. We can see some of the relationships between traditional articulatory descriptions and formants when we plot the formant frequencies given in Figure 1. The measurement of formant frequencies of English vowels had already been done by J.C. Wells In his M.A. thesis entitled *A Study of the Formants of the Pure Vowels of British English* in 1962, he measured the formant frequencies of 11 /hVd/ British English vowels. Here is the table of formant frequencies found by Wells.

Vowels	F1 (Hz)	F2 (Hz)
i:	280	2620
ɪ	360	2220
e	600	2060
æ	800	1760
ɑ	740	1180
ɒ	560	920
ɔ	480	760
ʊ	380	940
u	320	920
ʌ	760	1320
ɜ	560	1480

Table 1. Formant frequencies of British English vowels produced by adult male.

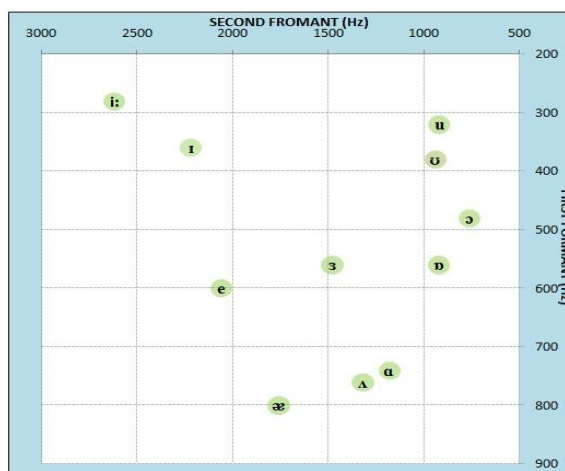


Figure 1. Data on British English vowels in Table 1 plotted as a traditional articulatory description (Bark scale)

The table will be used for comparison. The formant frequencies of English-L2 will be compared with the formant frequencies of British English native speakers in order to find out the distinctive features of vowel quality produced by English-L2.

### Indonesian Vowels and The Acoustic Features

Indonesian phonology indicates six monophthongs for the Indonesian vowel system; /i, u, e, ə, o and a/. There is allophonic variation between realisations in open and closed syllables but there is no agreement on the extent to which allophonic variation takes place (Halim, 1974:169). Indonesian vowels are pronounced differently in many regions in this country. However, these differences are only accents. To illustrate this, in South Sumatra, it is found that each of the six vowels, except /a/ and /ə/, is phonetically represented by two allophonic variants; according to Dardjowidjojo (1967) allophonic variation occurs in all monophthongs except /ə/. Subardi in Marsono (2008:37) stated that there are ten vowels due to Javanese interference.

Looking at the various statements, the number of Indonesian vowels vary according to its experts. Amongst the Indonesian monophthongs very few differences were acoustically observed. This has been a long dispute among the Indonesian linguists. Here, the Indonesian monophthongs are presented in a table based on some experts.

Words	Dardjowidjojo/Soebardi		Halim/Lapoliwa
Ikan, gila, kita, bila	1	i	i
Pinggir, kerikil, adik	2	I	Realization i
Ekor, enak, eja	3	e	e
Nenek, leher, gelang	4	ε	Realization e
Bata, kata, anak, ada	5	a	a
Elang, sela, reda, belah	6	ə	ə
Kota, pola, bola, roda	7	o	o
Otot, tokoh, dorong	8	ɔ	Realization o
Ukir, paku, bulan, utara	9	u	u
Ukur, urus, turun	10	U    ʊ	u

Table 2. The classification of Indonesian vowels

Acoustic measurements on Indonesian have not been reported by Indonesian linguists. There are many interesting theoretical problems connected with the vowel distinction. Here is the acoustic measurement of Indonesian vowels.

WORD	SYMBOL	FEMALE		MALE		AVERAGE	
		F1	F2	F1	F2	F1	F2
bila	i	303	2142	327	2062	315	2102
adik	I	390	1970	380	2010	385	1990
enak	e	814	2276	612	1761	713	2018
nenek	ε	744	2110	564	1648	654	1879
belah	ə	483	1721	436	1380	459	1550
bola	o	448	1073	549	1058	489	1065
tokoh	ɔ	575	1220	601	1367	588	1293
bulan	u	428	1618	390	1656	409	1637
ukur	o	428	1136	565	1404	496	1270
bata	a	805	1730	589	1365	697	1547

Table 3. Formant frequencies of adult speakers

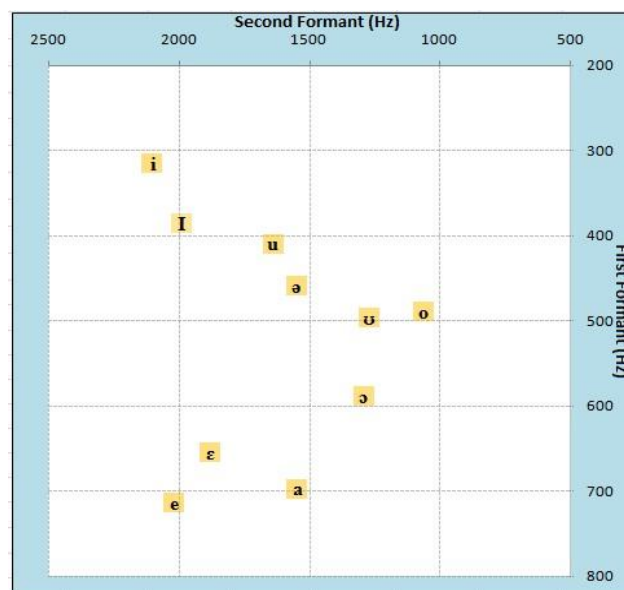


Figure 2. Data on Indonesian vowels in Table 3 plotted as a traditional articulatory description (Bark scale)

The difference between English and Indonesian becomes the main factor that Indonesian native speakers generally find it difficult to produce native-like sounds particularly in English vowels. Looking more closely at this problem, Dardjowidjojo (2009:49) compared English vowels with Indonesian vowels, he found that there are some vowels in English which could not be found in Indonesian, he even made a clear statement that Indonesian language does not have consistency in pronunciation. The different pronunciation in pronouncing /e/ and /ə/ in 'pegawai' is only allophonic, whereas in English, whether /e/ or /ə/ is a different phoneme in any kind English word.

In this research, what we need to know is in what ways vowels differ from each other or more accurately to discover the vowel quality. The first matter to consider in defining the vowel quality is the shape of the lips and the position of the tongue. Ladefoged (2010:20) made a brief summary about this gesture, he described in terms of three factors: (1) the height of the body of the tongue; (2) the front-back position of the tongue; and (3) the degree of lip rounding. Accordingly, vowels are classified into front and back vowels, high-low vowel, rounded and unrounded. He also stated that one important measurement in vowel is by using formant frequencies.

## Research Method

### Participants

This research involves ten participants who are native speakers of bahasa Indonesia (Indonesian). Five participants are male and the other five are female. They study English in English Department of Universitas PGRI Yogyakarta (PBI-UPY) and all participants have been studying English for at least 3 years. The participants had known that the recording of their voice will be used for educational and experimental purposes.

### Material

In this section, each participant was given a printed material containing a set of 11 /hVd/ words (*heed, hid, head, had, hard, hod, hoard, hood, who'd, hudd, herd*). After participants received the material then they were asked to listen to it in order to get better understanding and comprehension about the words. The listening materials taken from

*Oxford Advanced Learner's Dictionary*. Immediately after listening section, they were instructed to pronounce the words, simultaneously, the researcher started to record them.

### Recording Procedure

The recordings were made with Compaq CQ40 notebook and an attached headset-microphone placed at the distance of about 10 cm from the participants' mouth. The participants were recorded one by one in order to ease the analysis. This process took place in language laboratory of Universitas PGRI Yogyakarta.

### Analysis

The PRAAT software was applied to analyse the recordings, including measuring the formants of each vowel. The formant frequencies then plotted using spreadsheet in Microsoft Excel to serve the numerical data into chart which is similar to the traditional articulatory description of vowels.

### Findings and Discussion

The formant frequencies of British English vowels produced by Indonesian native speakers are served in following tables and figures.

VOWEL	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	AV
i:	390	331	305	371	346	454	547	394	468	429	403,5
ɪ	384	343	344	378	358	429	607	441	460	421	416,5
e	611	525	627	533	471	784	895	809	837	738	683
æ	564	594	584	567	625	808	942	508	720	715	662,7
ɑ	648	627	688	666	683	799	904	850	894	554	731,3
ɒ	373	555	355	516	446	739	761	770	690	768	597,3
ɔ	548	621	466	487	550	749	701	554	545	580	580,1
ʊ	389	409	316	398	361	449	542	443	449	805	456,1
u	387	387	331	398	415	478	526	427	455	477	428,1
ʌ	657	566	774	610	486	883	939	822	967	807	751,1
ɜ	603	503	591	561	578	568	628	591	713	518	585,4

Table 4. English-L2 F1 frequencies (value in hertz)

VOWEL	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	AV
i:	1949	1935	2432	2.009	2118	2537	1510	1326	2426	2462	2070,4
ɪ	1888	1933	2259	1.949	2093	2311	2095	1574	2219	2334	2065,5
e	1769	1626	2007	1804	1917	2160	1758	1144	1815	2149	1814,9
æ	1725	1464	2036	1770	1854	2182	2138	1793	1573	2112	1864,7
ɑ	1231	1315	1361	1409	1262	1442	1629	1431	1423	1581	1408,4
ɒ	1211	1290	1373	1118	1293	1265	1569	1390	1290	1688	1348,7
ɔ	897	1187	1279	1115	1041	1266	1400	1062	1137	1206	1159
ʊ	1183	1710	1283	1074	1444	1604	1279	1406	1211	1860	1405,4
u	1005	1703	1109	1099	1287	1015	1379	1418	1327	1425	1276,7
ʌ	1374	1456	1419	1802	1515	1761	1041	1285	1918	1822	1539,3
ɜ	1222	1438	1772	1466	1353	1621	1861	1426	1602	1488	1524,9

Table 5. English-L2 F2 frequencies (value in hertz)



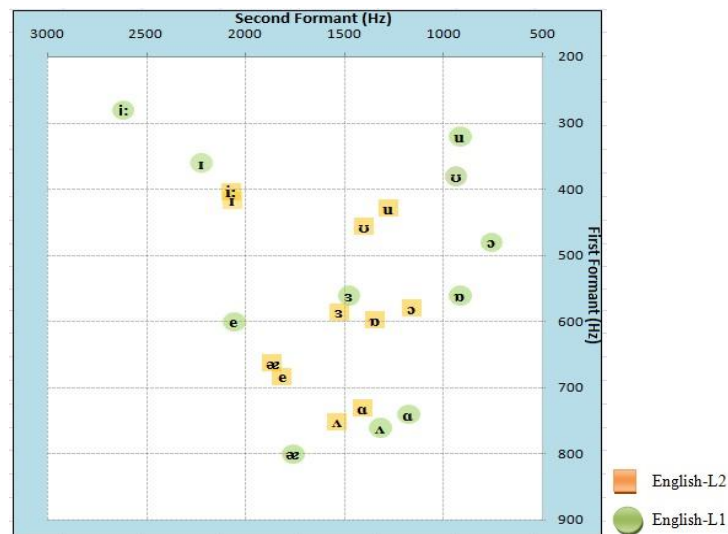


Figure 3. Comparison of English-L1 and English-L2



Figure 4. Comparison of English-L2 and Indonesian-L1

Table 4, 5 and figure 3 illustrate that there are some distinct characteristics of English-L2 vowel productions compared with English-L1. It can clearly be noticed that English-L2 vowel production is more tightly-clustered than that for Native speakers of British English. English-L2 tend to produce approximations to British English vowel when there is an equivalent vowel in Indonesian. It can be seen in figure 3 and 4 when the English vowels /ʌ/ and /ɑ/ have a closely equivalent in Indonesian /a/, the F1 and F2 frequencies of English-L2 are close to each other.

Vowel /æ/ and /e/ of English-L2 seem to be very close, it is seen from the average frequencies of F1 and F2 (F1 683, F2 1814,9 for /e/ and F1 662,7, F2 1864,7 for /æ/). English vowel /e/ is half-open front whereas /æ/ is an open front vowel and it is higher than /e/. However, vowel /e/ of English-L2 is apparently pronounced as open-front vowel and it is lower than /æ/.

The major differences appear in the production of vowel /i/ in 'heed' and /ɪ/ in 'hid' where the F1 and F2 frequencies of both vowels are identical (F1 403.5 Hz, F2

2070.4 Hz for /i/ and F1 416.5, F2 2065.5 for /ɪ/), English-L2 Learners are not able to discern the differences, both are pronounced as 'hid'. Another main distinctive utterances is /ɒ/ in 'hod' where F1 597.3 Hz and F2 1348.7 Hz, this vowel is closely perceived as /ɔ/ as in Indonesian 'tokoh' and the frequencies are in common with the vowel /ɔ/ as in 'hoard' produced English-L1. Furthermore, based on distant differences between F1 and F2, vowel /ɒ/ of English-L2 sounds more "front" instead of "back".

However, English-L2 produce a good impression of English vowel /ɔ/, the formant frequencies of the vowel are in common with the English-L1 when producing the same vowel. It can also be seen in figure 3 that both English-L2 and English-L1 plotted charts of vowel position are close to each other.

### Conclusion and Future Work

In conclusion, this research shows that English vowel production of English-L2 generally perceive English vowels which are different from English-L1. My analysis is that English-L2 are strongly influenced by their mother tongues. It is proved by the plotted frequencies which are more tightly-clustered. This pattern is similar to the plotted chart of Indonesian vowel produced by Indonesian-L1. From the eleven British English vowels, there is only one vowel /ɜ/ which is pronounced correctly and the formant frequencies are quite similar to British English native speakers.

This research is only a preliminary study which still requires further research related to acoustic features of English vowels produced by non-native speakers particularly Indonesian speakers. In this paper, I only report an average data of male and female respondents. Gender is known to be an important factor of phonetic variation. Gender and aged-related would also be interesting topic for future research. Hopefully, this research would be worthwhile for language teaching in Indonesia.

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ISBN 978-602-18681-9-5

